Appendix D

D.0 Monitoring

D.1 Tortoise Monitoring

D.1.1 Permanent Study Plot Methodology

In the 1970's, tortoise population studies were conducted on 47 plots. The method was to survey the sites intensively, locating all living tortoises and shell remains. In the early years, survey times of 15, 30, and 60 days were tested. Plot sizes of 1-2 square miles were used. For analysis of population trends, tortoise measurements are collected, and the sex is recorded. Shell remains are collected to derive minimum mortality and causes of death.

In the early 1980's, 15 of the 47 plots were selected by BLM as *permanent study plots* to be surveyed on a 4-year cycle. The Shadow Valley, Ivanpah Valley, and Goffs permanent study plots are located in the Northern and Eastern Mojave Planning Area. With designation of the Mojave National Preserve in 1994, only the Shadow Valley Plot is on BLM-administered land; however, the other two are within a few miles. Current methodologies involve two 30-day consecutive surveys (60 days total) of each plot; age-specific population estimates for each plot are computed using a modified Lincoln Index method. A description of the plot survey methods and the methods of analysis can be found in Turner and Berry (1984). Table E-1 shows the years the four plots have been surveyed.

Table D.1 – Desert tortoise permanent study plots in the Planning Area

Study Plot Name	Years Surveyed
Shadow Valley	1979, 88, 92
Ivanpah Valley	1979, 86, 90, 94,
Goffs	1980, 83-86, 90, 94, 00

The monitoring plots have provided valuable information on various demographic factors. Analysis yields such information as population density and trend, size-specific sex ratios, age structure, mortality rates, survivorship rates, and causes of mortality.

Until 1994, surveys and analysis of the permanent study plots were conducted by the BLM for the three plots on BLM-administered lands. In 1995, responsibility for these surveys was transferred to the Biological Research Division of the U. S. Geological Survey. In the past few years, funding for these surveys has been inconsistent.

In the early 1990's, the permanent study plot methodology came under criticism primarily because:

- The plot locations were not selected randomly but in relatively undisturbed locations
- The low number of plots does not adequately represent the variation present over the expanse of tortoise habitat
- There has been inconsistent funding resulting in variation in the 4-year sampling period;
- There is an invalid assumption that tortoises do not enter or leave the study plot during the entire spring study period
- Different size classes are not equally detectable
- Tortoise above ground activity may not be 100 percent in poor forage years and is not constant throughout the 60-day sampling period (Tracy, undated)

Despite the criticisms of this monitoring methodology, it has 20 years of history and has provided a tremendous amount of research material. This has resulted from collections of shells, measurements of tortoises, measurements of burrows, notes on predators and human uses, and other data besides counting tortoises. The Desert Tortoise Recovery Plan suggests that a new methodology giving more reliable trend information be developed to supplement but not replace the permanent study plots.

D.1.2 Distance Sampling Methodology

A number of alternative methods for measuring population density and, hence, determining trends in density have been examined in the field (Tracy undated). The selected technique for monitoring desert tortoise trends on a recovery unit basis is a *stratified distance-sampling/above-ground detection* methodology. In this method, each recovery unit is divided into homogeneous *strata*. The strata represent areas where 1) vegetation, soil, and topography are such that tortoises are everywhere equally visible, and 2) all tortoises are engaged in similar activity throughout the stratum at any given time. For the latter assumption, it is especially critical that the proportion active above ground is similar throughout the stratum. A separate survey is to be performed in each stratum.

In 1997 several teams of biologists met to delineate strata in the various recovery units. Strata were delineated only for areas of potential long-term management (i.e., Desert Wildlife Management Areas (DWMAs) as described in the Desert Tortoise Recovery Plan).

The proposed methodology is conducted with two teams, one team (Team A) searching a strip transect for tortoises, and one team (Team B) assessing the proportion above ground using radio telemetry. For Team A, a system of permanent line transects is positioned randomly in the stratum. Each transect is 4 km in length. Each transect is searched by 2-3 observers in a strip 10 meters on each side of the line. The area near the line must be searched thoroughly. For each tortoise sighted, the distance from the tortoise to the line is recorded. From these data a distance-detection function is constructed. This function is then used to estimate the number of tortoises above ground in the strip transect. A simple multiplication yields an estimate of the number of tortoises present above ground in the entire stratum. (Anderson and Burnham, undated)

Team B uses radio-telemetry equipment to relocate tortoises that have been previously radio-tagged. About 25 tortoises must be relocated in each stratum. From the relocation sightings, an above ground proportion is determined. This proportion is then used to correct the estimate from Team A to give a total estimate for the number of tortoises in the DWMA. (Anderson and Burnham, undated)

In 1999, a rangewide tortoise monitoring coordinator will be selected. This coordinator will move the trend monitoring program forward aggressively in subsequent years. Dr. Kristin Berry of U. S. Geological Survey will continue to manage permanent study plot assessments and data analysis for the California Desert.

D.2 Integrated Ecological Monitoring

Plans are underway for development of a California desertwide ecological monitoring program. This program is being developed under direction of the *Desert Managers Group*. The goal of the program is to evaluate ecosystem functions and resource sustainability in the California Desert. The elements of the program can be grouped into three areas:

1. **Early Warning** – This monitoring will give managers a comprehensive view of how the ecosystem is changing over time, especially in response to a range of human effects.
2. **Compliance** – This monitoring will indicate whether agency efforts are meeting various mandated responsibilities (e.g., recovery of endangered species).
3. **Diagnosis** – This monitoring will assess the effects of specific management actions, in particular their impacts on resources.

Under current plans, a regionwide monitoring coordinator will be selected as soon as funding is available. Then, a list of “vital signs” indicating ecosystem health will be identified, a range of alternative methodologies will be defined, monitoring sites will selected, thresholds of acceptable change will be established, and a data management system will be established.

D.3 Livestock Grazing Monitoring

Monitoring can be defined as the orderly, repeated collection and analysis of resource data to evaluate progress in meeting resource management objectives (this is based on BLM Manual 6600). The repetition of measurements over time for the purpose of detecting change distinguishes monitoring from inventory.

D.3.1 Types of Monitoring

Several types of monitoring have been identified. The following two are particularly relevant to monitoring livestock grazing (see MacDonald, et al. 1991, for a discussion of these and other types of monitoring).

Trend Monitoring

Monitoring to determine the long-term trend in a particular parameter. For example, is the population of a key species increasing, decreasing, or remaining stable at a particular site?

Implementation or Compliance Monitoring

This type of monitoring assesses whether activities were carried out as planned or whether livestock operators are complying with the terms of management plans and permits/leases. For example, did BLM construct the pasture fence in FY 1993 as called for in the activity plan? Did the operator move the mineral blocks at least 1 mile from the riparian-wetland areas as required in the allotment management plan? One of the major types of rangeland monitoring, involving the measurement of utilization is a form of compliance monitoring. We'll discuss this in detail below.

D.3.2 Levels of Monitoring

Qualitative and Semi-Quantitative Monitoring

Although many people equate monitoring with the gathering of some type of quantitative information, qualitative assessment of the condition of rangeland resources is a valid and important form of monitoring. Because of constraints related to limited budgets and workforces and the number of allotments for which BLM is responsible, qualitative monitoring is the level of monitoring most commonly employed in grazing management. Following are types of qualitative and semi-quantitative monitoring:

- **Stewardship integrity monitoring:** This involves visiting areas to ensure the habitat has not changed dramatically, as might occur with fire, overgrazing, trespass mining, vehicular use, etc. Aerial photography at specified intervals could also be used to assess some of these impacts without actually visiting the site.
- **Photoplots:** Photographs can provide important documentation of changes, particularly to habitat, over time. Although listed here under qualitative techniques, photoplots can also be used as a form of quantitative measurement. For example, several close-up photographs may be taken at a site and the number of individuals of the plant species of interest in each photograph counted or estimated.
- **Presence or absence:** Sites are visited to determine if a rare species is still extant or to determine whether a noxious weed has invaded a site.
- **Occurrence mapping:** An occurrence of a rare species or a riparian area may be mapped by delineating the distributional boundaries on the ground or on aerial photos.
- **Utilization pattern mapping:** Mapping the utilization made on key forage species is an important and effective form of grazing monitoring. The entire allotment or individual pasture is canvassed, usually following the removal of livestock, and the amount of utilization in different areas on one or more key plant species is assessed. Areas are then mapped into several classes based on level of utilization (e.g., no use, light use, moderate use, and heavy use). Ocular estimation is often used to assign areas to one of these classes, but sometimes quantitative studies are also used (e.g., utilization transects are established in different areas of the allotment and used to assign these areas to a particular utilization class).

Utilization mapping is usually done each year for several years to determine if patterns are consistent from year to year. Where rest rotation grazing systems are in place, yearly mapping is normally conducted until the completion of at least one rotational cycle. The results of utilization pattern mapping can then be used to identify over-utilized areas of the allotment in need of adjustment through different management and to locate key areas (discussed below) for future monitoring studies.

- **Other observations:** Additional information deemed to be important may be collected based on ocular estimates. Examples are: presence/absence of individuals of a key species in different size classes; rough categorical estimate of the percent of plants in each size class; presence/absence of a defined condition in individuals at a given location (e.g., flowering, diseased, infested by insects, dead); rough categorical estimate of the percent of plants exhibiting the condition (e.g., 25-50% flowering).

The strengths of qualitative and semi-quantitative monitoring are that it is quick and therefore inexpensive, it allows assessment of large areas, such as complete allotments and pastures, it provides insight on condition and management needs, and it can serve as a "red flag" to trigger quantitative monitoring. The weaknesses of this type of monitoring are that different observers may reach different conclusions when no real difference exists; the interpretation is somewhat subjective; it provides purely descriptive information with no potential for analysis; and the only detectable change is often dramatic and severe.

D.3.3 Quantitative Monitoring

In performing quantitative monitoring studies you *measure* something. This can mean, for example, that you count the number of individuals of a key plant species (either in total or by size class), you estimate its cover in plots, or you measure the size (height, cover or both) of individual plants. Quantitative monitoring involves taking a sample to estimate something about the parameter of interest, such as the cover or vigor of a key species in a pasture. Because sampling is involved, there is error around estimates of these parameters that must be considered in analysis. Statistical analysis takes these sampling errors into account when determining whether changes have occurred or thresholds (such as utilization levels) have been crossed.

D.3.4 Key Area Concept

Many, if not most, rangeland vegetation monitoring studies employ the key area concept. Using this approach, key areas are selected (subjectively) that (we hope) reflect what is happening on a larger area. Key areas are areas chosen to be representative of a larger area (such as a pasture) or critical areas such as riparian-wetland areas and sites where endangered species occur. Monitoring studies are then located in these key areas.

Although we would like to make inferences from our sampling of key areas to the larger areas they are chosen to represent, there is no way this can be done in the statistical sense because the key areas have been chosen subjectively. An alternative is to sample the larger areas, but the constraints of time and money coupled with the tremendous variability usually encountered when sampling very large areas often makes this impossible. The key area concept represents a compromise.

Because statistical inferences can be made only to the key areas that are actually sampled, it is important to develop objectives that are specific to these key areas. It is equally important to make it clear that actions will be taken based on what happens in the key area, even when it can't be demonstrated statistically that what is happening in the key area is happening in the area it was chosen to represent. It is also important to base objectives and management actions on each key area separately. *Values from different key areas should never be averaged*.

D.3.5 Key species concept

Just as the key area concept is a compromise between sampling an entire allotment versus sampling only a portion of it, the key species concept is a compromise between tracking change in all plant species versus tracking change in those species that are most likely to be affected by management. The latter species are called key species and are chosen based on several criteria. First, they are usually species that are preferred forage for livestock. Thus, they can be expected to increase under proper grazing management and decrease under improper grazing management. They therefore provide valuable information on the success of management. Second, they should be common enough that monitoring them will not be overly difficult or intensive. Third, changes in the distribution, vigor, or abundance of these key species should be representative of similar changes to other species deemed to be important to the plant community desired for a particular site. In this instance key species serve as keystone or indicator species. A fourth criterion that can be employed is legal status: special status plants may be singled out to be monitored regardless of their rarity or whether they function as keystone or indicator species.

D.3.6 Long-term (trend) monitoring

What most interests the range manager is how ecosystems (including plant and animal communities and abiotic factors such as soil) change over time in response to management. Usually only vegetation is monitored and an assumption made that if certain types and amounts of desired vegetation are present then the desired animals and desired soil conditions are also present. The assessment is made through either quantitative or qualitative monitoring studies usually located in key areas of the allotment. Photoplots and checklists are the principal qualitative monitoring method used in trend monitoring. An example of the checklist approach is the proper functioning condition checklist used in riparian areas. Although this approach can be considered to be inventory, its use at the same site on two or more occasions is a form of monitoring.

Quantitative monitoring methods are several and usually entail the measurement of some attribute of key species at key areas. The Interagency Technical Reference, Sampling Vegetation Attributes (BLM et al. 1996a), includes most of the types of range studies employed by BLM nationwide. In the EIS area the two most common quantitative trend methods involve the use of cover and frequency measurements.

Cover measurements entail the estimation of the percentage of ground surface covered by vegetation. Three types of cover are measured, depending on the measurement method and the biology of the target plant(s). *Canopy cover* is the area of ground covered by the vertical projection of the outermost spread of the foliage of plants, including any small openings in the canopy. Canopy cover measurements are used in estimating the cover of shrubs, trees, and herbaceous plants. The line intercept method (BLM et al. 1996a) is most often used to estimate shrub and tree cover or, alternatively, aerial photographs are used. Canopy cover of herbaceous plants is usually made using plots, such as those described for the Daubenmire method (BLM et al. 1996a). *Foliar cover* is the area of ground covered by the vertical projection of the aerial portions of plants, with small openings in the canopy excluded. This is the type of cover measured by the point intercept method (BLM et al. 1996a), a method used primarily for herbaceous plants. *Basal cover* is the area of ground surface occupied by the basal portion of plants. This is the type of cover often used to monitor changes in bunchgrasses or tree stems. The basal area of bunchgrasses is estimated using line intercepts or estimation in plots. Several methods are applicable to the estimation of tree basal cover; these, however, are rarely used in grazing-related monitoring and will therefore not be discussed here.

Depending on objectives, cover is measured on key species, on all species, or on broad cover categories (e.g., live vegetation, litter, bare ground, and gravel). Total ground cover is important in determining whether sites are adequately protected from accelerated wind and water erosion. Cover of key species is important in determining whether objectives relative to increasing or maintaining the key species are being met.

Changes in the canopy and foliar cover of herbaceous species can be difficult to interpret because they can vary widely with climatic fluctuations. It is therefore difficult to tell whether changes are due to grazing management, weather, or a combination of both. Basal cover is much less sensitive to climatic fluctuations and a better indicator of trend in those species that are amenable to basal cover measurement (e.g., perennial bunchgrasses). The canopy and foliar cover of most woody shrubs does not vary nearly as much as herbaceous plants with climatic fluctuations, and these types of cover are often used to assess trend due to management (sub-shrubs, however, can present the same interpretation problems as herbaceous plants).

Frequency is another attribute often used to assess long-term trend on rangelands. It is one of the easiest and fastest methods available for monitoring vegetation. Frequency is the number of plots (called quadrants) occupied by a particular species, expressed as a percentage. For example, let's say we decide to sample 100 randomly placed 1m x 1m quadrants in a key area. If 40 of these have Key Species A in them, then we say that the frequency of Key Species A in that key area is 40 percent (note that we are interested only whether the species is present or absent in each quadrant--a species is present in a quadrant if 1 or if 100 plants occur in it). We then compare this 40 percent frequency with the value we come up with the next time the key area is sampled to determine if the trend in this key species is up, down, or static. The best results are obtained when frequencies range from 20-80 percent.

Unlike cover, which is not dependent on the type or size of sampling unit used, frequency is only meaningful when the same quadrant size and shape is used in each year of measurement. When measuring the frequency of more than one plant species, it is often difficult to use the same size quadrant and maintain a frequency of 20-80 percent for all species. In these situations a nested frequency quadrant is often used. For example, within a 1m x 1m quadrant, three other quadrant sizes, 50cm x 50cm, 30cm x 30cm, and 10cm x 10cm, are nested. At each random placement of the quadrant, the smallest to the largest quadrant size is searched for the target species. If the species is found in the smallest quadrant, then it is also found in all other quadrants; if it is not found in the smallest quadrant, then the next smallest quadrant is searched, and so on. Once the first year's data are collected, optimal quadrant sizes can be determined for each species.

Changes in frequency can be due to changes in density or spatial pattern. Interpretation can be difficult because of this. However, if the data are recorded on a quadrant-by-quadrant basis, if seedlings and established plants are recorded separately, and if other trend data such as cover are collected at the same time, interpretation becomes easier.

The vertical structure of vegetation can be extremely important to wildlife. This is especially true in riparian areas. Most offices monitor this through the use of photoplots and other qualitative methods. Some offices use quantitative techniques such as the cover board method (BLM et al. 1996a) to monitor vertical structure.

D.3.7 Short-term (Utilization) Monitoring

Except for very favorable sites, such as riparian-wetland areas, changes in vegetation attributes such as frequency and cover can be very slow, making it hard to detect these changes until many years or even decades have passed. This lag time not only makes it difficult to assess the effects of management, it can place the natural resources at risk: if the changes, once they are detected, are in the wrong direction, correcting this downward trend may be all that more difficult or even impossible. Supplementing long-term monitoring with short-term monitoring studies is a means of reducing this risk. These short-term studies monitor the amount of utilization made on key plant species.

Management objectives are developed that specifies how much utilization is allowed on key species before livestock are moved off a pasture. Utilization is then estimated through monitoring studies, and management actions implemented accordingly. These management actions can consist of taking immediate action in the same year (i.e., immediately moving livestock out of the pasture once the utilization threshold is approached or crossed) and of making long-term changes to the livestock grazing on an allotment (i.e., reducing stocking rate or season of use if utilization levels are consistently high).

Several methods are used by different field offices in California to estimate utilization. The Interagency Technical Reference, Utilization Studies and Residual Measurements (BLM et al. 1996b) describe these methods.

Most current BLM land use plans allow for utilization of key perennial grass species of 50 percent of the annual above-ground production (some plans specify a range of 40-60 percent utilization). Holechek (1991), however, points out that:

> A 50% use level works well in the flat, humid regions of the Great Plains and Southeast because of their high productivity and high adaptability of the plants to grazing. However in most cases it causes range destruction in the rugged, arid ranges of the West. Research shows stocking rates that involve a 30 to 40% forage use level will enhance range recovery, maintain adequate food and cover for wildlife, protect soil resources and will give the highest long term economic returns with the least risk on nearly all of the western range types (see reviews by Holechek et al. 1989, Vallentine 1990).

It is also important to estimate utilization on shrubs, where these species are important components of the ecosystem. Areas that support shrub species that are used by livestock and wildlife include:

- Riparian areas, which often support willows and other shrubs
- Areas within the sagebrush steppe where bitterbrush and other shrubs are important components
- Areas where saltbushes and other related shrubs occur, both in the sagebrush steppe and annual grassland vegetation types

There are 19 allotments (an area determined to be suitable for grazing) within the NEMO planning area. Eight allotments are located within the Ridgecrest Resource Area, ten within the Needles Resource Area and one in the Barstow Resource Area. With the passage of the CDPA, three allotments have portions located in Death Valley National Park, and eight allotments have portions located in the Mojave National Preserve.

D.4 Literature Cited

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